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AQUACULTURE EXTENSION SERVICES REVIEW :

THAILAND

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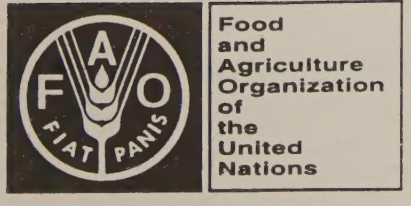

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AQUACULTURE EXTENSION SERVICES REVIEW : THAILAND

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ROME, 1996

PREPARATION OF THIS DOCUMENT

In 1982, FAO Fisheries Circular N. 747 entitled "Aquaculture extension services review" was published. This publication gave a brief outline of the status of aquaculture extension services in 32 countries. In those early days of aquaculture development, aquaculture extension services were in their infancy, and in many countries they were not in existence.

The last decade, however, has seen dramatic development of aquaculture, especially in Asia. It is believed that the extension services played an important role in this rapid development by effectively transferring culture technologies to the producers. It is therefore important that the present status of the aquaculture extension services are reviewed, especially in the countries where aquaculture development is believed to have made some impacts on the socio-economic life of the rural people.

Bearing this in mind, this review has been prepared within the framework of the Normative Programme activities of the FAO Inland Water Resources and Aquaculture Service of the Fishery Resources Division. The original text, prepared by Mr. Kumron Potipitak in Bangkok, has been edited by Mr. P.C. Choudhury in Rome. Bibliographie references are as submitted by the author.

The author gratefully acknowledges the assistance of various institutions under the Royal Thai Government for providing data/information related to the subject matter.

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ABSTRACT

Thailand, a country with a total area of 513,155 km^2 and a coastline of 2,815 km, has a population of about 60 million. The country is endowed with abundant water resources and fertile agricultural land. Agriculture, including forestry and fisheries, employs two-third of the population.

Fisheries is an important sub-sector contributing 1.5% of the GDP. Fisheries products have increased in both volumes and values from 2.2 million tons and 19,238 million bahts, respectively, in 1983, to 3.2 million tons and 65,545 million bahts in 1992. Out of a total aquaculture production of 371,000 tons, contributions from marine (including brackishwater) aquaculture and inland freshwater aquaculture were 229,000 tons and 142,000 tons, respectively (1992). Thailand, however, is the world leader in the production of cultured shrimps.

Aquaculture extension services are provided by the Fisheries Extension Division (FED) of the Department of Fisheries (DOF). The FED implements extension activities through the Provincial Fisheries Offices. The DOF has over 500 field personnel for carrying out regular extension activities. The Northeast Fishery Project (NFP), funded jointly by the Royal Thai government and the Canadian International Development Agency (CIDA), has been the most ambitious aquaculture extension project designed to help improve rural nutrition and income within the context of integrated rural development in the Northeast region of Thailand. The DOF is now implementing 19 Aquaculture Extension Packages for Occupational Development Project. Among the extension methods followed, farm visits, training, result demonstrations, mass media are the most favoured ones. The DOF provides low-interest rate credit and supplies subsidized inputs such as fish/shrimp seed, lime, fertilizer, feed etc. to encourage poor farmers to start aquaculture.

Aquaculture extension services have achieved a great deal of success during the last decade. Aquaculture production has increased by 4.5 times, from 82,700 tons in 1982 to 371,000 tons in 1992. Number of fish farmers have increased from 74,971 in 1988 to 103,790 in 1992. However, lack of credit facilities, infrastructure and technical information for rural farmers have hindered further development of aquaculture.

LIST OF ABBREVIATIONS

CIDA =	Canadian International Development Agency
DOF =	Department of Fisheries
EEZ =	Exclusive Economic Zone
FAO =	Food and Agriculture Organization
FED =	Fishery Extension Division
FMO =	Fish Marketing Organization
FRFP =	Fish in Rice Field Programme
GDP =	Gross Domestic Product
GNP =	Gross National Product
LSIFP =	Large Swamp Inland Fisheries Project
MOU =	Memorandum of Understanding
NFP =	Northeast Fishery Project
NGO =	Non-Governmental Organization
NSO =	National Statistics Office
OAE =	Office of Agricultural Economics
PO =	Plan of Operation
SFPP =	School Fish Pond Programme
TEW =	Temporary Extension Worker
US =	United States
VFP =	Village Fish Pond

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1. BACKGROUND OF THE COUNTRY

1.1 Introduction

Geography

Thailand is situated in the central part of Indochina Peninsula. It lies between the latitudes of 5° 27'N and 20° 27'N and the longitudes of 97° 20'E and 105° 37'E. Thailand is classified into five regions. The central region is the alluvial floodplain of the Chao Phraya River, extended by narrow valleys along the main tributaries. The northern region, the most mountainous region, cover 75% of the country and the Doi Inthanon (2,576 m) is the highest peak in Thailand. It was traditionally the most heavily forested area. The northeast region constitutes about one-third of the area of the country comprising the Korat Plateau. The soil is mostly of sandy loam, highly permeable to water. The southeast region comprise the hilly forested country southeast of Bangkok and is characterized by higher rainfall and poorer soils than the adjoining central region. The southern region or peninsula Thailand, south of latitude 11, is sharply divided by the central mountain range into east and west coast tracts.

The country shares its borders with four neighbouring countries, namely Myanmar, Laos, Kampuchea, and Malaysia (Fig.1). The total length of its land boundary is 5,326 km. Its coastal boundary along the Gulf of Thailand and the Andaman Sea has the length of 1,878 km and 937 km, respectively, amounting to 2,815 km altogether. The total area of Thailand is 513,115 square kilometres.

Climate

Water resources of Thailand come from two main sources - surface water and ground water. These include rainfall, river basin, lakes, canals, swamps, irrigation water, and underground water. Thailand receives rainfall at an average volume of some 752 billion m^3 annually (OAE, 1992). The north, northeast and central regions have a tropical monsoon climate with three distinct seasons: rainy season from May to October, cool season from November to February and summer from March to April. The monthly temperature in April may reach 40-42 degree Celsius, and the winter temperature in the north and northeast can fall to 10 degree Celsius or lower. The average rainfall in these regions is 1,250 mm per year, while the Korat Plateau receives less than 500 mm per year. The south and southeast regions have a tropical rain forest climate. Rainfall occurs virtually throughout the year, the average annual rainfall reaching 3,000 mm or more along the coast. There is little variation in temperature, around an average of 28 degree Celsius. March and April are normally the driest months of the year.

Land & water resources

Agriculture, including forestry and fisheries, employs some two-thirds of the population in Thailand. Some 102,000 km^2 of land, representing 20% of the total area, are cultivated and some 180,000 km^2 are covered by forests. The country is self-sufficient in food, producing 23.04 million tons of crops in 1990. The Chao Phraya Central Plain has the best rice growing fields. Thailand is the world's number one exporter of rice, and second of rubber and fifth of sugar and cassava, and is one of the world's largest producers of teak. An area of 5,500,000 ha of freshwater constitutes more than 10% of the total area, including reservoirs, lakes, rivers, swamps and fish ponds, in addition to 18,000 km^2 of flood area and 31,000 km^2 of irrigated rice fields (FAO, 1993).

Figure 1: Map of Thailand, showing its neighbouring countries (from Karnjanakesorn, 1992)

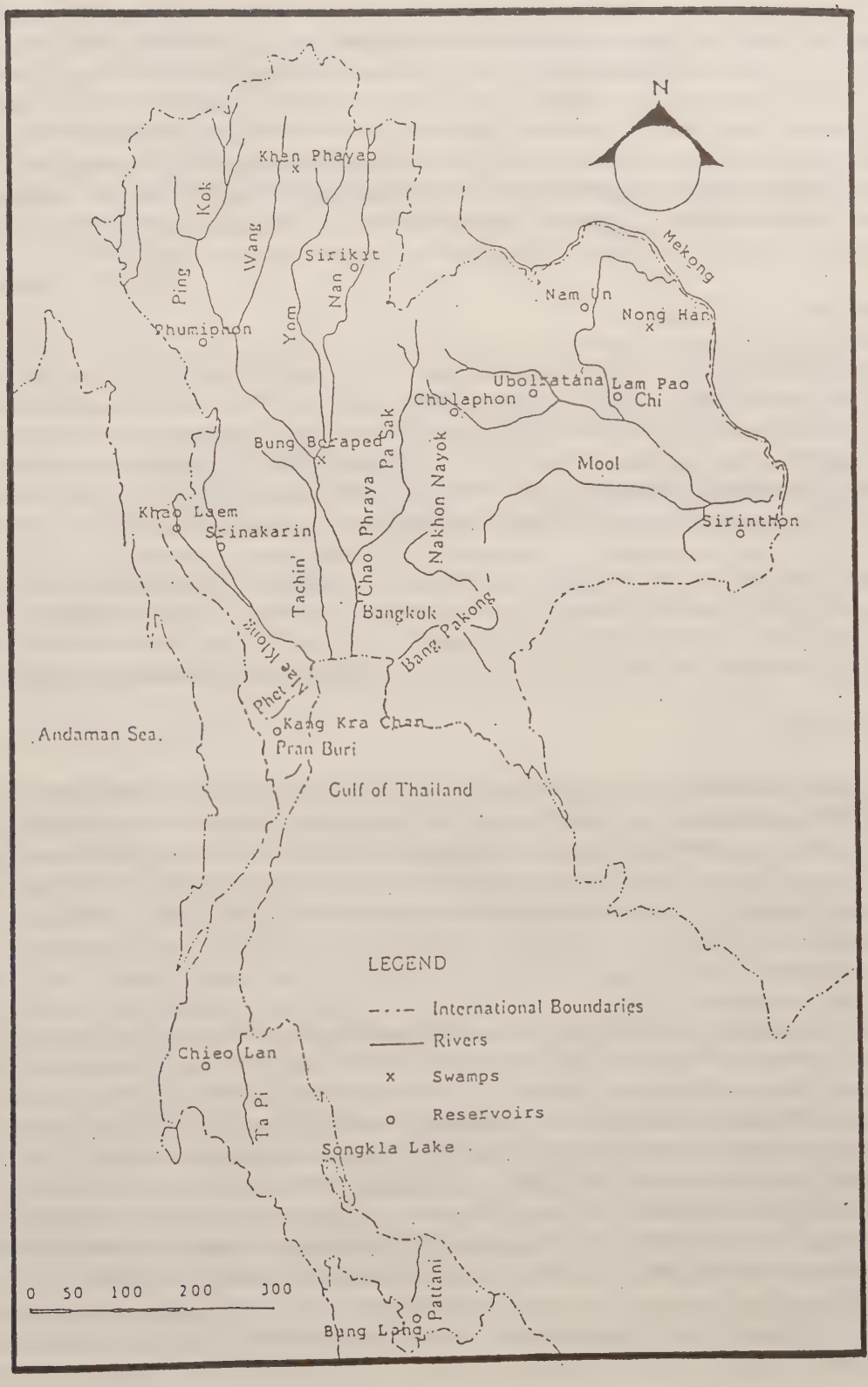

Figure 2: Map of Thailand, showing its major rivers, swamps, and reservoirs (adapted from Chalayondaja and Thongkam, 1990)

Fishery Resources in Thailand are harvested from the Gulf of Thailand, the Andaman Sea, rivers, lakes, streams, canals and reservoirs. The harvest includes fish, crustaceans, molluscs and other marine and freshwater fauna and flora. During the past three decades the country's marine fisheries have been rapidly developed, contributing to an average annual output of about two million tons. This has placed Thailand to the top ten marine fishery product producing countries in the world. Nevertheless, the proclamation of the Exclusive Economic Zone (EEZ) by neighbouring countries in 1980 has resulted in loosing about 800,000 square kilometres of Thai fishing grounds as well as bringing about frequent fishing conflicts. To resolve the problems, the Thai Government has promoted the joint-fishing venture with other coastal states in recent years (OAE, 1992).

Demography

Thailand had an estimated total population of 56,961,030 in 1991 with the yearly population growth rate of 1.2% (Alpha Research Co., Ltd., 1992). The population has increased to 58.1 million in 1993 (Pinnoi, 1993). Most of Thailand's population is located in the countryside. Agricultural population accounted for 35.85 million in 1991, or 62% of the total population in the country. Active labour force in agriculture was estimated at 19.48 million, approximately 67% of the total labour force (OAE, 1992).

A typical Thai farm family consists of five persons and extends beyond the nucleus of parents and their offspring to include grand-parents, cousins, or other relatives. Within the household, 67% of the total family members are in active labour, the remaining are elderly and young members. About 50% of the active members are engaged in farming.

Nutrition/health

Out of a total population of 58.1 million in 1993, about eight million children were found to be suffering from malnutrition (Pinnoi, 1993). Fish is a basic component of the average Thai diet where a variety of food preparations can be made from a wide range of fish and/or fish products. High nutritional value, its good taste and ready availability make fish an important source of nutrition particularly for rural people (Pongsri, 1994).

Economic status

Thailand has high economic growth rate. Its economic growth rate in 1994 was 8.5% with the Gross Domestic Product (GDP) of 2,684.5 billion bahts (Bank of Thailand, 1995). The GDP in agriculture contributed about 11.3% of the total GDP in 1994, whereas that of fisheries contribution was 12.3% of the agricultural GDP or about 1.5% of the total GDP. Thai fisheries products have increased in both quantities and values from 2,255,400 tons and 19,238 million bahts in 1983 to 3,239,800 tons and 65,545 million bahts in 1992. The percentage of increase in quantity and values were about 44% and 240 %, respectively. The increase was due to the increased catches from marine waters of neighbouring countries and the increased production of black tiger shrimp from coastal aquaculture.

Import/export

Thailand imported fish and crustaceans valued at 25,646 million baht in 1991 (2.7% of the total country import value of 959,408 million baht) and this ranks 9th among the most important import products (Alpha Research Co.,Ltd, 1992).

Shrimp and prawn are major export commodities contributing to large amount of foreign exchange earnings annually. Shrimp and prawn exports are processed into chilled, frozen, dried, boiled, and canned products. Thailand's important markets of frozen shrimps and prawn are Japan, the United States, the European Union, Taiwan (Province of China) and Singapore.

Among these products, the total of 148,879 tons of black tiger shrimp (*Penaeus monodon*) was exported with the value of about 37,840 million baht and this ranked 4th among the exported agricultural products in 1993 (Fisheries Economics Division, 1994).

Employment in fisheries

Fisheries sector plays important roles in producing fish for local consumption and in earning foreign exchange. It provides employment opportunities in both capture fisheries and aquaculture. There are also large number of employees in post-harvest industries such as cold storage, fish processing, fishmeal, fish sauce, ice mill and shipyard. An employment survey in marine capture fisheries in 1990 found that there were 148,360 people employed in marine fisheries (NSO, 1992a). The Fisheries Economic Division also conducted a preliminary survey of employment in post-harvest industries and found that there were 65,924 persons employed in the industries. It is estimated that about 145,000 households are engaged in aquaculture and that aquaculture employs over 300,000 labourers (Table 14).

1.2 Present Status of Capture Fisheries

Inland capture fisheries

There are 47 major rivers and many natural lakes, swamps, reservoirs and community fish ponds in Thailand. The total surface area of these waters is estimated at 5,300 km^2. Chookajorn and Bhukaswan (1987) stated that there are 20 multi-purpose reservoirs in Thailand with the total surface area of 285,272 ha. The total annual yield is estimated at 13,400 tons, with the average annual yield of 47 kg/ha. Map of Thailand, showing its major rivers, swamps, and reservoirs is shown in Fig. 2. Indigenous species such as minnows and clupeids contribute significantly to the harvest. There are about 18,000 fishermen who fish in Thai reservoirs. The major fishing gear used is gillnet. FAO (1992) reported that about 46% of the total inland fisheries production of Thailand comes from capture fisheries.

Fish stocking and regulated fishing are two management measures used in Thailand to optimize fish yields from inland waters. A stocking programme, initially started with stocking snakeskin gourami (*Trichogaster pectoralis*) and tilapia (*Oreochromis mossambicus*) into swamps, and later using other exotic species such as common carp, rohu, Nile tilapia and Chinese carps. The emphasis has recently shifted to using local species for the improvement of fish yield in reservoirs (e.g. tawes) or for conservation or repopulation of economically important species whose populations have been declining as a result of intensive fishing and altered habitats. At present, over 100 million fingerlings of various fish species are stocked into reservoirs annually (FAO, 1992).

Table 1 shows fish production obtained from inland capture fisheries from 1983 to 1992. The fish production fluctuated between 81.5 to 136.0 thousand tons/year, with the highest production (136,000 t) achieved in 1991.

Table 1: Fisheries production of Thailand by sub-sectors, 1983-1992

Unit: 1,000 tons

Year	Total	Capture		Aquaculture
		Marine	Inland	
1983	2,255.40	2,055.20	108.4	91.8
1984	2,214.80	1991.5	111.4	111.9
1985	2,225.20	1,997.20	92.2	135.8
1986	2,536.30	2,309.50	98.4	128.4
1987	2,779.10	2,540.00	87.4	151.7
1988	2,629.70	2,337.20	81.5	211
1989	2,740.00	2,370.50	109.1	260.4
1990	2,786.40	2,362.20	127.2	297
1991	2964.7	2,475.60	136	353.1
1992	3,239.80	2,736.40	132	371.4

Table 2: Aquaculture production of Thailand, 1983-1992

Unit:1,000 Tons

Year	Marine Aquaculture	Inland Aquaculture	Total
1983	44.7	47	91.7
1984	61.6	50.4	112
1985	60.6	75.3	135.9
1986	39.1	89.3	128.4
1987	61.8	89.8	151.6
1988	108.9	102.1	211
1989	168.7	91.7	260.4
1990	193.2	103.8	297
1991	230.4	122.7	353.1
1992	229.3	142.1	371.4

Marine capture fisheries

Out of a total marine production of 2.7 million t (1992 Table 1), about 76% came from fishing grounds in the Gulf of Thailand, while the remaining (24%) came from the Andaman sea. Marine resources can be divided by habitats and fishing gears into two categories i.e. pelagic and demersal resources. The catch ratios of these two kinds of resources vary with market demand. At present, the catch percentages of pelagic and demersal fish are 32% and 68%, respectively.

1.3 Present Status of Aquaculture

Thailand has a long history of fish culture. Releasing fish in public waters as a religious activity started since the beginning of Buddhism. However, the beginning of fish culture in Thailand is uncertain, but is believed to have started as early as 1691 according to the book of Culturing of Goldfish by Ingelbert Dampfore (Tarnchalanukit, 1974). Documented concrete evidence shows that in 1921 when the Government of Siam (later Thailand) led by the King Rama VI, hired Dr. H.M. Smith as the fisheries advisor to establish a basic fisheries foundation for the country (Suraniranat, 1979). Five years later the Department of Fisheries (DOF) was founded and Thai aquaculture activities started to grow systematically.

Aquaculture prior to the World War II (1941-1946) was limited to a small group of people since marine and freshwater fish catches were abundant. During the World War II, shortages of gasoline and other necessities led to a massive rise in food price including fish. This crisis brought about an increase in the number of people that got involved in fish farming and husbandry management (Yosaengrat, 1957).

There are more than 25 species used in aquaculture production, whereas only 14 species are most commonly cultured. These are walking catfish (*Clarias batrachus*), snakehead (*Channa striatus*), striped catfish (*Pangasius sutchi*), tawes (*Puntius gonionotus*), gouramy (*Trichogaster pectoralis*), sand goby (*Oxyeleotris marmoratus*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), Nile tilapia (*Sarotherodon nilotica*), freshwater prawn (*Macrobrachium rosenbergii*), sea bass (*Lates calcarifer*), grouper (*Epinephelus tauvina*), and tiger prawn (*Penaeus monodon*).

Aquaculture in Thailand can be categorized into inland and marine aquaculture. Total aquaculture production in 1992 was 371,400 t (Table 2). Inland aquaculture has been practised in Thailand for over five decades with various degrees of success. There are about 27 species of fish being cultivated under various types of systems ranging from super-intensive farming for commercial production to extensive, mainly for home consumption. More than 60,000 inland farms with the total cultivated area of 49,752 ha exist. Over 95% of the total area consists of pond and paddy-field type culture systems. The remainder are dammed-up ditches, swampy areas and cage culture systems. The total Thai freshwater aquaculture production for the year 1992 was 142,100 tons with the top seven species being Nile tilapia, striped catfish, tawes, gouramy, catfishes, freshwater prawn and snakehead fish. Table 3 shows fish production and the total areas under inland aquaculture from 1978 to 1992.

Before the eighties, yield of the cultivated species were not promising since only extensive farming system was applied (Saisithi, 1989). Marine aquaculture, particularly of shrimp and fish, were rapidly developed in the past ten years. The total production of marine shrimp and fish were increased from 15,840 and 629 tons in 1985 to 184,884 and 3,555 tons in 1992, respectively (Table 4). The increase in production was made possible due to the development of modern culture techniques, availability of seed produced by artificial breeding, improved knowledge in nutrition, and higher demand from overseas markets. However, shortage of *Penaeus monodon* seed will continue to be a major problem in coastal aquaculture.

Table 3. Fish production from inland aquaculture, 1978-1992

Year	Total Area (ha)	Fish production (1,000 tons)
1978	24,292	39.4
1979	24,462	29.5
1980	25,189	34.5
1981	26,191	48.1
1982	27,795	45.8
1983	41,087	47.0
1984	37,224	50.4
1985	40,625	75.3
1986	44,661	89.3
1987	51,614	89.8
1988	52,239	102.1
1989	49,752	91.7
1990	49,723	103.8
1991	50,434	122.7
1992	58,177	142.1

Source: Fisheries statistics of Thailand
Fisheries Statistics Sub-Division
Department of Fisheries

Tiger shrimp, sea bass, and grouper are the main species group for intensive cultures. Production of tiger shrimp in 1985 were only 106 tons and production reached nearly 180,000 tons in 1992. Production of sea bass and grouper followed the same trend reaching 2,592 and 964 tons in 1992 (Table 4).

Thailand has been the world leader in shrimp production in the past three years. In 1992, the total value of cultivated tiger shrimp exceeded US$ 1,000 million. The total value of sea bass and grouper was only US$ 20 million (US$ 7.4 million for sea bass and US$ 12.7 million for grouper) as shown in Table 5. The higher values with lower volume of grouper indicates better farm-gate price of grouper than that of sea bass. The price per kg of grouper and sea bass in 1992 were US$ 13.2 and US$ 3.2, respectively (DOF,1994).

Table 4: Marine aquaculture production (tons) classified by groups of cultured animals

Year	Marine shrimp	Marine fish	Mollusc	Total
1985	15, 840	629	42,158	58,628
1990	188,227	1,635	73,000	192,862
1991	162,069	2,005	66,300	230,374
1992	184,884	3,555	40,613	229,052

Source : DOF (1993a, 1994)

Table 5: Marine aquaculture production (tons) and value (US$ million) classified by species

Year	Tiger shrimp	Value	Sea bass	Value	Grouper	Value
1985	106	0.70	512	1.40	188	0.43
1990	107,968	540.30	1,214	3.60	421	2.20
1991	155,069	769.10	1,650	5.30	344	4.00
1992	179,357	1,002.20	2,592	7.40	964	12.70

Source : DOF (1993a, 1994)

The main policy goal for aquaculture development is to increase aquaculture production for export rather than for local consumption. For this reason, the species of high international demand i.e. marine shrimp, tilapia and channel catfish are considered to be the priority targets. For marine shrimp, all research should answer the question "How to sustain or to increase shrimp production in Thailand?"

DOF has clear policies to sustain the marine shrimp culture development. These can be summarized as follows:

1) The total cultured area should be kept limited to the present acreage; not to exceed 76,000 ha.
2) The traditional culture and semi-intensive culture should be converted to intensive culture.
3) The shrimp farms must treat and improve discharged water before releasing into natural waters.
4) The sea-water irrigation system is being implemented, in all major areas of shrimp culture, in order to improve the quantity and quality of sea-water supply and to facilitate effluent discharge from marine shrimp farms.
5) The process of hatchery and farm registration should be strengthened to ensure shrimp product quality.
6) In 1994, DOF has established shrimp inspection laboratories in most maritime provinces. The laboratories are used to investigate the level of antibiotic residues in farmed shrimps before harvesting. This will assure that the shrimp sold to cold-storages are free of antibiotic residues.

7) Research on maturation of marine shrimp spawner in captivity should be encouraged to minimize the use of spawners from the wild.
8) Research on shrimp genetics to develop the fast-growing and disease tolerant strains should be conducted.
9) Research for alternative species which are suitable for culture in pond should be conducted.

2. AQUACULTURE INSTITUTIONS

2.1 Development and Management

Administrative structure of DOF is divided into two parts: the central administrative and regional administrative parts. The central administrative part includes 28 divisions, whereas the regional administrative part includes 75 provincial fisheries offices and 398 district fisheries offices.

The organizations within DOF that share responsibility for aquaculture management and development in Thailand include six divisions (Freshwater Fisheries Division, Coastal Aquaculture Division, Feed Quality Control Development Division, Fishery Engineering Division, Fishery Economics Division, Fishery Extension Division), four institutes (National Inland Fisheries Institute, National Institute of Coastal Aquaculture, Aquatic Animal Health Research Institute, National Aquaculture Genetics Research Institute) , 20 Fisheries Centres, 57 Fisheries Stations, 75 Provincial Fisheries Offices and 398 District Fisheries Offices throughout the country. Institutional structure of DOF is shown in Fig.3.

2.2 Research

Research in aquaculture may be classified into six major areas: fish culture, fish nutrition, fish disease, fish genetics, fishery engineering, and fish farm management. The institutions responsible for fisheries research, with special reference to aquaculture, include 9 central fisheries divisions/institutes (Freshwater Fisheries Division, National Inland Fisheries Institute, Coastal Aquaculture Division, National Institute of Coastal Aquaculture, Feed Quality Control Development Division, Aquatic Animal Health Research Institute, National Aquaculture Genetics Research Institute, Fishery Engineering Division, and Fishery Economics Division) and Provincial Fisheries Offices (Fig. 4).

2.3 Education and Training

Suraswadi (1990) commented that future human resources needs in fisheries industries for the fisheries development in Thailand should be the skilled labours in marine fisheries and well-trained scientists in fisheries processing and coastal aquaculture. Therefore, two levels of education should be provided by educational institutions, a certificate level for the skilled labour programme and an university degree level for the well-trained scientist programme. There are at least three public universities (Kasetsart University, Khon Kaen University, and Prince of Songkhla University) and a private university (Asian Institute of Technology) involved in aquaculture research and development.

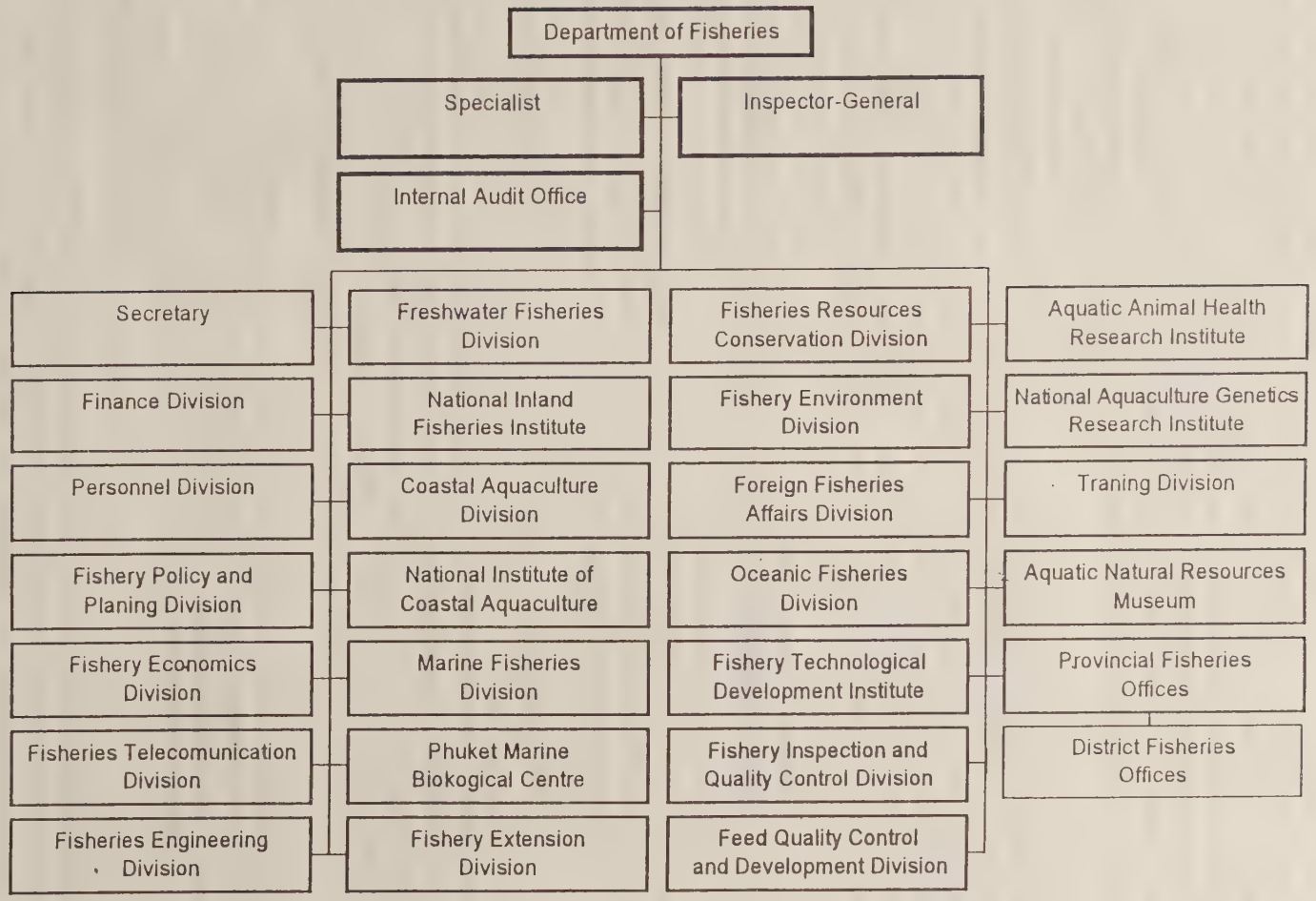

Figure 3: Institutional structure of the Department of Fisheries

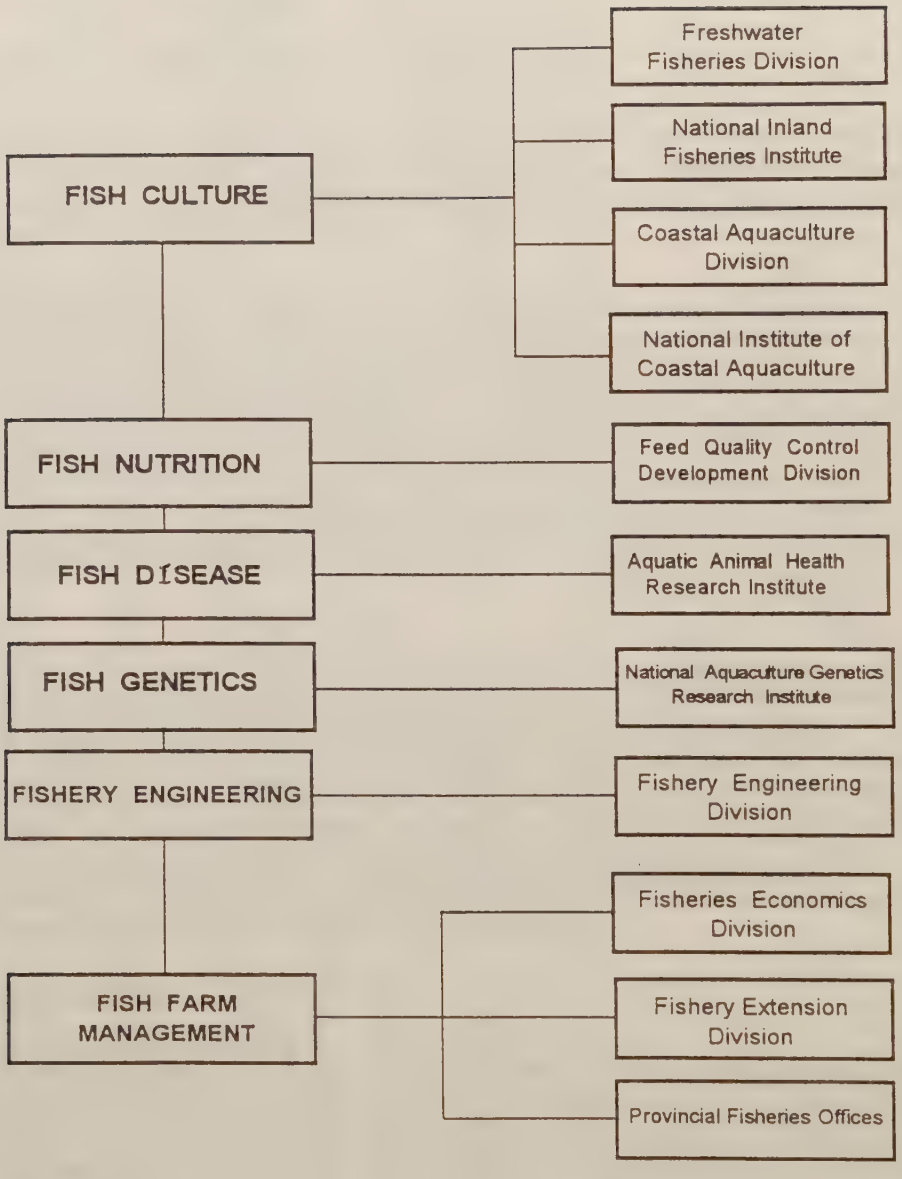

Figure 4: Functional structure of Fisheries Research Institutions in aquaculture

3. PRODUCTION, MARKETING AND ECONOMICS

3.1 Production

Aquaculture production in Thailand can be classified into three categories: mariculture, brackishwater culture and freshwater culture (Table 6). Mariculture refers to the culture of bloody cockle, green mussel, oyster and house mussel, etc. Brackishwater culture refers to the culture of sea bass, grouper and shrimp *(Peneaus monodon)*, etc. Freshwater culture refers to the culture of giant prawn, snake-head fish, walking catfish (*Clarias spp.*), catfish *(Pangasius sutchi)*, sepat siam, Nile tilapia, sand goby and local Thai carps, etc. The number of farmers involved in various types of aquaculture production has increased from 74,971 in 1988 to 103,790 in 1992 (Table 7).

Mariculture and brackishwater fish culture or coastal aquaculture are practised along the coastal areas, particularly in the Gulf of Thailand and the Andaman Sea, whereas freshwater fish culture is practised throughout the country. The total production of aquaculture in 1992 was 371,158 tons from 147,535 ha of cultured areas. Of this total, 40,613 tons was obtained from mariculture (Table 9) and 188,440 tons was obtained from the brackishwater (Table 8). Production of freshwater fish culture was 142,105 tons (table 10 & 11).

Brackishwater culture has contributed 51 % of the total production and 42% of the total value of aquaculture production.

The fluctuations in the annual total production are mainly due to the fluctuations in the mariculture production. During 1987-1992, the mariculture production increased sharply. The trends of aquaculture production by species groups are described below:

Marine shrimp culture

The shrimp culture production contributes about 51% of the total aquaculture production. During 1983-1992, shrimp production increased sharply from 11,550 tons to 184,884 tons and the number of farms and areas have also increased. The current practice is a capital-intensive method. The average productivity is about 2500 kg/ha/year. Table 8 shows that the productivity has steadily increased since 1983.

In spite of the economic success of Thai shrimp farming, the rapid development of intensive system has imposed problems on the coastal aquatic environment resulting from the effluent discharges from shrimp farms. Intensive shrimp farming requires inputs of high protein and phosphorus diets. Much of the feed is not consumed and released into coastal waters causing eutrophication.

In addition, the deterioration in water quality has led to disease outbreak and high mortality. The recent occurrences of shrimp mass mortalities under intensive culture conditions in some cultured areas indicate an overload of the environmental carrying capacity. The effluent from shrimp ponds has also caused salinization of agricultural land, which has led to conflicts with rice farmers. The operation of shrimp farms in mangrove areas has considerably contributed to the loss of mangrove forests in some parts of the country.

Table 6 : Aquaculture production of Thailand, 1983-1992

Year	Brackishwater Culture		Mariculture		Freshwater Culture		Total	
	Quantity (tons)	%	Quantity (tons)	%	Quantity (tons)	%	Quantity (tons)	%
1983	11,963	13.5	29,841	33.6	46,966	52.9	88,770	100.0
1984	13,532	12.4	45,188	41.4	50,411	46.2	109,131	100.0
1985	16,470	12.3	42,158	31.5	75,254	56.2	133,882	100.0
1986	18,810	14.8	18,875	14.9	89,325	70.3	127,011	100.0
1987	25,067	16.6	35,859	23.8	89,782	59.6	150,708	100.0
1988	57,025	27.1	51,399	24.4	102,128	48.5	210,552	100.0
1989	95,232	36.7	72,936	28.1	91,680	35.3	259,838	100.0
1990	119,862	40.4	72,982	24.6	103,754	35.0	296,598	100.0
1991	164,075	46.5	66,300	18.8	122,680	34.7	353,054	100.0
1992	188,440	50.8	40,613	10.9	142,105	38.3	371,158	100.0

Source : Fisheries Economics Division,Department of Fisheries,Thailand

Table 7: Numbers of farmers by type of culture, 1988-1992

Year	Inland Aquaculture	Marine Aquaculture			Total
		Fish	Shrimp	Others	
1988	59,439	2,221	11,838	1,473	74,971
1989	60,497	2,524	14,235	1,580	78,836
1990	61980	2,657	16,299	1,717	82,653
1991	67,163	2,506	18,998	1,934	90,601
1992	78,473	3,768	19,403	2,146	103,790

In the inner region of the Gulf of Thailand, increasing deterioration of the marine environment caused by industrial, domestic and shrimp farm effluent has been observed. Most shrimp farms have been forced to abandon culture areas. The level of national shrimp production has been maintained only by increased intensification along the eastern and southern coasts of Thailand. However, those farms are now also facing environmental and disease problems. A coastal environmental plan of action is needed to control negative environmental impacts and to make shrimp farming sustainable.

Sea bass and grouper culture

The brackishwater fish cultures are being carried out on a very limited scale. The major species cultured are sea bass, grouper and milkfish. Unfortunately, very little statistics are available; Table 8 shows the trend of sea bass and grouper production from 1983 to 1992. The sea bass and grouper production has increased with their highest productions achieved in 1992.

Sea bass and grouper culture are practised in three types of enclosures such as ponds, paddy fields and cages. Most of the culture practices are in cages with a total area of 241 ha. At present, the grouper culture areas are much smaller than those of the sea bass.

Mollusc culture

Mollusc production of Thailand is dominated by bloody cockle and green mussel. During 1986-1992, the total quantity increased sharply from 18,875 tons (in 1986) to 72,982 tons (in 1990), with a decrease in 1991 and 1992 (Table 9). The decline of the total quantity of mollusc in 1991 and 1992 was caused by the decrease in the amount of bloody cockle and green mussel production. The green mussel production contributes the highest quantity while the bloody cockle is the second. It can be noted that the production of the bloody cockle in 1992 was higher than that of the green mussel.

Table 8 : Production of brackishwater culture of Thailand, 1983-1992

Year	Marine Shrimp Culture				Sea Bass and Grouper Culture		
	Areas (ha)	Quantity (tons)	Value (million B.)	Yield/unit (Kg./ha)	Areas (ha)	Quantity (tons)	Value (million B.)
1983	35,537	11,550	950	325	n.a.	413	31
1984	36,792	13,008	1,024	354	n.a.	525	39
1985	40,769	15,841	1,348	389	n.a.	630	47
1986	45,368	17,886	1,738	394	59	925	72
1987	44,770	23,566	3,449	526	68	1,501	157
1988	54,778	55,633	7,901	1,016	98	1,392	161
1989	71,166	93,495	11,072	1,314	93	1,737	181
1990	64,606	118,227	14,365	1,830	80	1,635	144
1991	75,332	162,070	19,834	2,151	65	2,005	231
1992	72,796	184,884	25,500	2,540	241	3,556	503

Source : Fisheries Economics Division,Department of Fisheries,Thailand

Freshwater fish culture

The areas under freshwater culture from 1983 to 1992 are shown in Table 10. The total production of freshwater fish culture in 1992 was 142,000 tons equivalent to 3,478 million bahts. The top five species in terms of volume were tilapia (30.9%), Thai silver carp (16.8%), walking catfish (16.7%), catfish (10.0%), and sepat Siam (9.1%). Whereas in terms of value (Table 11), there were giant prawn (25.8%), tilapia (17.6%), walking catfish (17.0%), Thai silver carp (14.4%), and sepat Siam (8.5%). There are four types of freshwater fish farming in Thailand, i.e., pond culture, paddy field culture, ditch culture and cage culture. The production from the pond culture is highest, accounted for nearly 80% of the total production and more than 80% in value, followed by paddy field culture, ditch culture and cage culture. The production from freshwater fish culture increased sharply after 1963 due to the success in artificial breeding. In 1988 the production surpassed 100,000 tons for the first time.

3.2 Marketing

The Thai-Japan Large Swamp Inland Fisheries Project (LSIFP) described three levels of freshwater fish marketing in Thailand. At central level, the activities are mostly concentrated in Bangkok and other few provinces utilizing the facilities of Fish Marketing Organization (FMO). Fish after passing through some channels are handled by brokers or retailers before it reaches the consumers. In the normal process, fish either collected from fish farms or fish landing sites by local fish mongers who then deliver the fish to either brokers at FMO's facilities or directly to retailers in Bangkok. Some of the fish from these facilities are sold by the retailers to the consumers in Bangkok and the rest transported to provincial markets. At provincial level, the fish mongers or fishermen may deliver fish to provincial wholesalers who afterward distribute the product to retailers in the province or provinces nearby. At the local level, fish is sold either by local fish mongers or fishfarmers directly to local consumers.

Domestic Market

The Government institution that directly deal with fish marketing is the Fish Marketing Organization (FMO). The functions of FMO are to develop fish wholesale market and to promote fisheries occupation and cooperation. So far, only the first function has been "successfully" pursued. At present, FMO operates three wholesale markets in Bangkok and eleven fishing ports or market places along the coast. In these markets, fish are sold through auction system.

In case of brackishwater aquaculture and mariculture, traders are fishfarmers, fish agents/collectors, wholesalers and retailers. Some large-scale farmers are also fish product traders and fish agents. Some Fish agents are registered with FMO and the non-registered fish agents conduct their businesses in private or in municipal markets. Fish agents can be the first traders receiving fish from farmers and trade by auction and/or negotiation.

Trading method employed at FMO fish markets is mainly auction. In case of non-registered fish agents, the trading method is price bargaining. Generally, farmers who sell the fish at private fish market places may have some contracts with the fish agents who usually own the market places or cold storages. Thus, the influence in pricing tends to be exerted by the fish agents rather than the farmers. Nevertheless, this problem occurs only for the small-scale farmers since large-scale farmers are usually fish agents and they have more market outlets.

Table 9 : Mariculture production of Thailand, 1986-1992

Year	Bloody Cockle			Green Mussel			Oyster			Other			Total		
	Areas (ha)	Quantity (tons)	Value (million B.)	Areas (ha)	Quantity (tons)	Value (million B.)	Areas (ha)	Quantity (tons)	Value (million B.)	Areas (ha)	Quantity (tons)	Value (million B.)	Areas (ha)	Quantity (tons)	Value (million B.
1986	1,132	6,928	31	196	11,095	19	455	580	11	74	272	1	1,857	18,875	62
1987	1,119	6,909	44	471	23,949	44	784	1,483	17	84	3,518	2	2,458	35,859	107
1988	1,198	4,652	32	351	44,237	93	617	1,858	25	86	652	2	2,252	51,399	152
1989	958	12,822	82	496	58,669	131	678	1,399	23	87	46	3	2,219	72,936	239
1990	1,081	12,299	79	476	58,380	136	744	1,370	25	86	933	2	2,387	72,982	242
1991	1,566	26,442	157	300	35,455	88	768	3,311	49	80	1,092	3	2,714	66,300	297
1992	1,510	18,804	120	203	14,032	44	826	3,774	54	73	4,003	8	2,611	40,613	226

Source : Fisheries Economics Division,Department of Fisheries,Thailand.

Table 10 : Areas of freshwater fish culture of Thailand, 1983-1992

Year	Nile Tilapla (ha)	Common crap (ha)	Thai Siver crap (ha)	Chainese crap (ha)	Walking catfish (ha)	Catfish (ha)	Snake-head (ha)	Sepat Siam (ha)	Macrobra--chium (ha)	Others (ha)	Total (ha)
1983	4,236	1,278	2,785	7,948	197	518	74	18,063	1,965	332	37,397
1984	4,287	1,314	2,945	1,612	262	598	77	17,923	2,818	287	32,123
1985	7,704	1,850	5,055	1,470	544	1,013	107	18,896	3,558	428	40,625
1986	8,201	2,097	5,573	1,494	621	1,026	109	18,523	6,557	460	44,661
1987	8,559	2,066	6,597	1,150	530	1,104	109	17,824	13,047	628	51,614
1988	8,896	1,896	5,580	193	483	1,089	85	17,623	9,532	453	45,832
1989	10,398	2,234	7,395	182	876	1,336	102	17,729	8,794	704	49,752
1990	11,213	2,241	8,322	140	1,130	1,376	106	17,490	7,044	660	49,723
991	12,728	2,351	8,830	208	1,506	1,413	102	17,691	4,906	699	50,434
1992	16,972	2,480	10,240	158	2,132	1,548	137	18,147	5,511	851	58,177

: Fisheries Economics Division,Department of Fisheries,Thailand

Table 11 : Production of freshwater fish culture of Thailand, 1983-1992

Year	Nile Tilapia (Tons)	Common crap (Tons)	Thai Siver crap (Tons)	Chainese crap (Tons)	Walking catfish (Tons)	Catfish (Tons)	Snake-head (Tons)	Sepat Siam (Tons)	Macroba-clum (Tons)	Others (Tons)	Total (Tons)
1983	12,090	1,914	5,051	857	2,961	6,962	4,754	9,326	1,153	1,898	46,966
1984	7,953	1,211	4,914	1,220	4,598	8,182	4,863	11,781	3,102	2,587	50,411
1985	15,110	1,549	7,312	1,011	6,393	13,786	7,364	16,577	15	6,137	75,254
1986	18,366	1,858	8,791	1,773	15,816	12,574	5,986	16,129	77	7,955	89,325
1987	16,979	2,130	11,144	1,602	13,875	11,822	3,294	14,269	11,837	2,830	89,782
1988	18,810	2,473	12,973	1,046	12,550	20,352	4,041	14,901	10,913	4,069	102,128
1989	21,114	1,967	13,369	874	12,383	13,539	3,732	13,196	7,949	3,557	91,680
1990	22,834	2,109	14,646	951	17,908	13,336	3,786	12,799	8,485	8,900	103,754
1991	28,105	2,474	16,274	107	29,135	14,517	5,566	13,280	7,766	5,456	122,680
1992	43,935	2,386	23,840	1,265	23,775	14,176	4,714	12,959	10,307	4,748	142,105

Source : Fisheries Economics Division,Department of Fisheries,Thailand

For freshwater fish, farm harvested fish can be sold through local traders (mostly retailers) or through collectors who channel their fish to wholesalers and retailers. Most of them are live fish, transported by truck and kept in water tanks.

It can be noted that only a small percentage of the cultured products are sold through Bangkok FMO fish market (Tokrisna, 1986). Most of the cultured products landed at wholesale fish market in other provinces are transported directly to the local retail markets without being channelled through the central fish market in Bangkok.

Fish marketing facilities are still not adequate, thus making fish trading uncompetitive. The central wholesale markets are located close to Bangkok. Bangkok wholesale fish market seems to have reached its maximum capacity. Landing points are numerous and scattered. More marketing facilities e.g. markets with facilities for auction, ice plants, cold storage and refrigerated transportation are needed.

Export

The growth of exports of fishery products during the past decade has been remarkable. By 1992, the value and volume of fish/seafood exports had risen to 82.5 billion bahts and 1.1 million tons, respectively; showing an eight-fold and four-fold increase when compared with 1982. The most important component was the marine shrimp, 80% of which was from aquaculture. Thailand is the top exporter of marine shrimp product in the world. In 1992, the total volume and value of shrimp export was 171,924 tons and 39,937 million baht, respectively (Table 12).

Table 12 : Quantity and value of Thai shrimp exports, 1982-1992

Year	Fresh and Frozen		Other		Total	
	Quantity (Tons)	Value (million Baht)	Quantity (Tons)	Value (million Baht)	Quantity (Tons)	Value (million Baht)
1982	22,647	2,764	4,973	414	27,620	3,178
1983	20,150	3,164	5,524	448	25,674	3,612
1984	19,428	2,712	17,866	1,560	67,294	4,272
1985	24,037	3,439	18,156	1,561	42,193	5,000
1986	28,729	4,391	21,193	1,831	49,922	6,222
1987	33,090	5,749	27,126	2,572	60,216	8,321
1988	49,810	9,698	16,306	2,896	66,116	12,594
1989	74,194	16,057	25,914	3,143	100,108	19,200
1990	84,719	20,454	31,712	5,202	116,431	25,656
1991	121,189	26,672	36,514	6,623	157,703	33,295
1992	130,359	31,667	41,565	8,270	171,924	39,937

Source : Fisheries Economics Division,Department of Fisheries,Thailand

A Cabinet resolution of 21 December 1993 authorized the Department of Fisheries to issue certificates of hygiene for export of fishery products. In January 1994, the DOF commenced the Development of Raw Materials and Fisheries Products Inspection System Project. The objectives of the project are to promote and accelerate the development of fishery products for export meeting the high standards of quality and hygiene that are required by the regulations of the importing countries. The project includes the establishment of Raw Materials Inspection Units in 22 coastal provinces and Fisheries Products Inspection Centres in two provinces. Under this project, all raw materials and fishery products for export must be inspected and certified by DOF.

3.3 Economics

The costs and profits of aquaculture production are summarized in Table 13.

Table 13. Culture economics of selected major species

Type of culture	Size of farm (ha)	Production (Kg/ha)	Costs (baht/ha)	Net profit (baht/ha)
Brackishwater culture:				
Marine shrimp[1/]	1.10	845	639,961	174,810
Mariculture:				
Bloody cockle[2/]	3.89	19,390	89,192	33,547
Freshwater culture:				
Nile tilapia[3/]	1.46	5,542	38,382	24,514
Common carp	0.45	889	10,149	7,851
Thai silver carp	0.34	7,053	61,832	45,082
Chinese carp	0.32	5,359	34,313	27,106
Walking catfish	0.64	20,045	306,739	99,184
Snake-head fish	1.40	10,091	408,360	58,022
Sepat Siam	4.48	713	16,037	5,776

Note: [1/] NSO (1992a)
[2/] Sittimung et al. (1994)
[3/] OAE (1994)

3.4 Socio-Economic Benefits

In general, aquaculture is capital intensive and does not require large labour inputs. Substitution of capital by labour is limited since ponds, pumps, feed mills, and other capital items are required to operate an aquaculture installation. Labour is primarily required for feeding, harvesting, and maintenance activities. In hatchery operation, some skilled employees may be required for artificial breeding. The estimated employment figures (Table 14) show that the total households engaged in aquaculture are 145,158 or 313,060 fulltime labourers. Of this number, 77% are engaged in freshwater fish culture and the rest are engaged in coastal aquaculture.

The average household income from aquaculture depends on the farming system practised, highest (292,000 Baht/household/yr) from shrimp culture to lowest (4000 Baht/household/yr) from common carp culture (Table 15).

Fish is the primary source of animal protein for most of Thailand's population with the average per capita availability of 20.3 kg, representing 53% of the total animal protein consumption. Assuming that the capture and culture fish are equally consumed, the per capita consumption of aquaculture product is estimated at about 1 kg.

Table 14: Estimated employment by types of aquaculture, 1992

Items	Total households	Labourer per household	Estimated total no. of labourer
1. Brackishwater culture	23,170		69,436
Shrimp	19,402	3.27	63,445
Sea Bass & Grouper	3,768	1.59	5,991
2. Mariculture	2,146		3,941
Oyster	1,597	1.93	3,082
Green Mussel	250	1.15	288
Blood Cockle	245	2.11	517
Other	54	1.00	54
3. Freshwater culture	119,842	2.00	239,684
TOTAL	145,158		313,061

Source : Fisheries Economics Division, Department of Fisheries, Thailand

Table 15: Average farm household income by culture systems

Type of farm household	Average net income (baht/household/year)
Brackishwater culture: Shrimp culture [1]	291,722
Mariculture Bloody cockle culture [2]	10,306
Freshwater culture [3]	45,581
Nile tilapia	4,136
Common carp	18,202
Thai Silver carp	10,716
Chinese carp	68,277
Walking catfish	86,956
Snake-head fish	38,548
Sepat Siam	

Note: [1/] NSO (1992b)
[2/] sittimung et al. (1994)
[3/] OAE (1994)

4. AQUACULTURE EXTENSION SERVICES

To describe aquaculture extension, it is necessary to understand the practice of aquaculture in Thailand. Aquaculture in Thailand can be divided into two main categories: coastal and freshwater aquaculture (DOF, 1993b). Coastal aquaculture in Thailand is very much developed and very commercialized. Most practices require high investment and at the same time can generate a big income for farmers. The practices of coastal aquaculture are mostly conducted in commercial scale with big capital investment. On the other hand, freshwater aquaculture is mainly practised by poor farmers in the rural agricultural areas. It is done with little investment and as an additional income generator. Only some farmers practice freshwater aquaculture on a commercial scale. The majority of the aquaculture practitioners are farmers with low income, but whose main career is in agriculture. They practise aquaculture to produce fish for food and to generate additional income. In general, aquaculture can be categorized into three types according to levels of investment and income generation.

i. Subsistence aquaculture practice which is carried out by the majority of aquaculture practitioners. It is practised mainly for producing fish for family consumption and for additional income, with very little inputs of money and time. The culture system is usually extensive type.

ii. Commercial aquaculture practice which is carried out only for realizing profit. This group is relatively small in numbers, but it is very important to national economy. It generates large amount of foreign exchange. It involves large investment in semi-intensive/intensive operations.

iii. Semi-commercial practice which is somewhat between the first two categories. Most fish farmers who fall in this category were previously subsistence fish farmers. Some of the successful, entrepreneur subsistence fish farmers by investing money and time have graduated to semi-commercial farmers. They, in addition to growing fish for food, generate substantial income from their operations. The culture system is semi-intensive type.

4.1 Extension Service Organization

The Department of Fisheries (DOF), which is under the jurisdiction of the Ministry of Agriculture and Cooperatives, consists of 28 institutions/divisions, including the Fishery Extension Division (FED). The current organization of the extension services under the FED are organized through six sections. These include Administration, Fishery Extension and Planning, Audio-Visual Aids, Extension Materials and Public Relations, Training, and Fishery Loan and Subsidy (Fishery Extension Division, 1991).

Aquaculture extension services in Thailand are mainly executed by DOF. Therefore, this paper reviews the extension organization according to DOF's organization. In the past, DOF did not have any extension offices which were directly responsible for extension works of the department. Most extension works at that time were administered by provincial fisheries stations and provincial fishery offices. The provincial fishery offices are responsible for administrative fisheries activities and fisheries conservation in natural waters. In the past, these fisheries stations were responsible for extension works because they had fishery biologists and fishery extension workers to conduct the extension

activities. They also produced fish seed which could be used to increase fish production for rural communities. Later, DOF had reorganized itself to increase its efficiency in fisheries extension.

In 1987, the Fisheries Extension Division was set up in order to administer aquaculture extension programmes. Its main functions are to plan and administer extension programmes of the Department of Fisheries (Fisheries Extension Division, 1990). At the same time DOF removed its extension activities from the provincial fisheries stations to the provincial fisheries offices in order that the provincial fisheries stations could concentrate on aquaculture research and fish seed production. The strong point in favour of the provincial fisheries offices for doing extension programmes is that they employ skilled workers who have been working in the field. However, this reorganization has created a gap between research and extension. In 1993, DOF also established the Training Division. It has taken the responsibility for developing human resources for both the DOF and farmers.

A simplified organization of the extension services of DOF is shown in Fig 5. Administrative section within DOF provides work plan and budget for extension programmes. These plans and budget are sent directly to provincial fisheries offices. At the same time, the Fishery Extension Division translates the extension policies and plans into operational plans which also comply to limitation of the budget before sending it out to provincial fisheries offices. A provincial fisheries office also administers the district fisheries offices within each province. A district fisheries office is an operating unit of DOF in the field. The number of DOF extension workers are very few when compared to large areas and population of target groups under extension services. Some extension programmes of DOF have to rely on staff of other government agencies such as the Agricultural Extension Department which has staff working in every sub-districts of Thailand. Besides, the fishery officers and workers at the district fisheries office also have other responsibilities such as fisheries administration and conservation.

At present, DOF has about 520 field personnel who work as extension workers. Most of them have at least a certificate in agriculture. A large number of them had graduated with a Bachelor Degree in various disciplines, including agricultural extension. From time to time, these personnel participate in training courses in various fields that are related to their works in extension service. Such training courses are organized by the Training Division and other external institutions. There are also training and other study programmes in foreign countries, but they are very limited due to lack of financial support.

In Thailand, farmer organizations are not strong. In every village, there is at least a farmer organization which is supported by the government. Fisheries organizations or cooperatives can be found in the fishing areas along the coast and in the areas where aquaculture activities are extensive. Main functions of these organizations are to secure markets for their products and to build up their bargaining power. At present, DOF has not managed to utilize the support of these organizations for implementing its extension programmes.

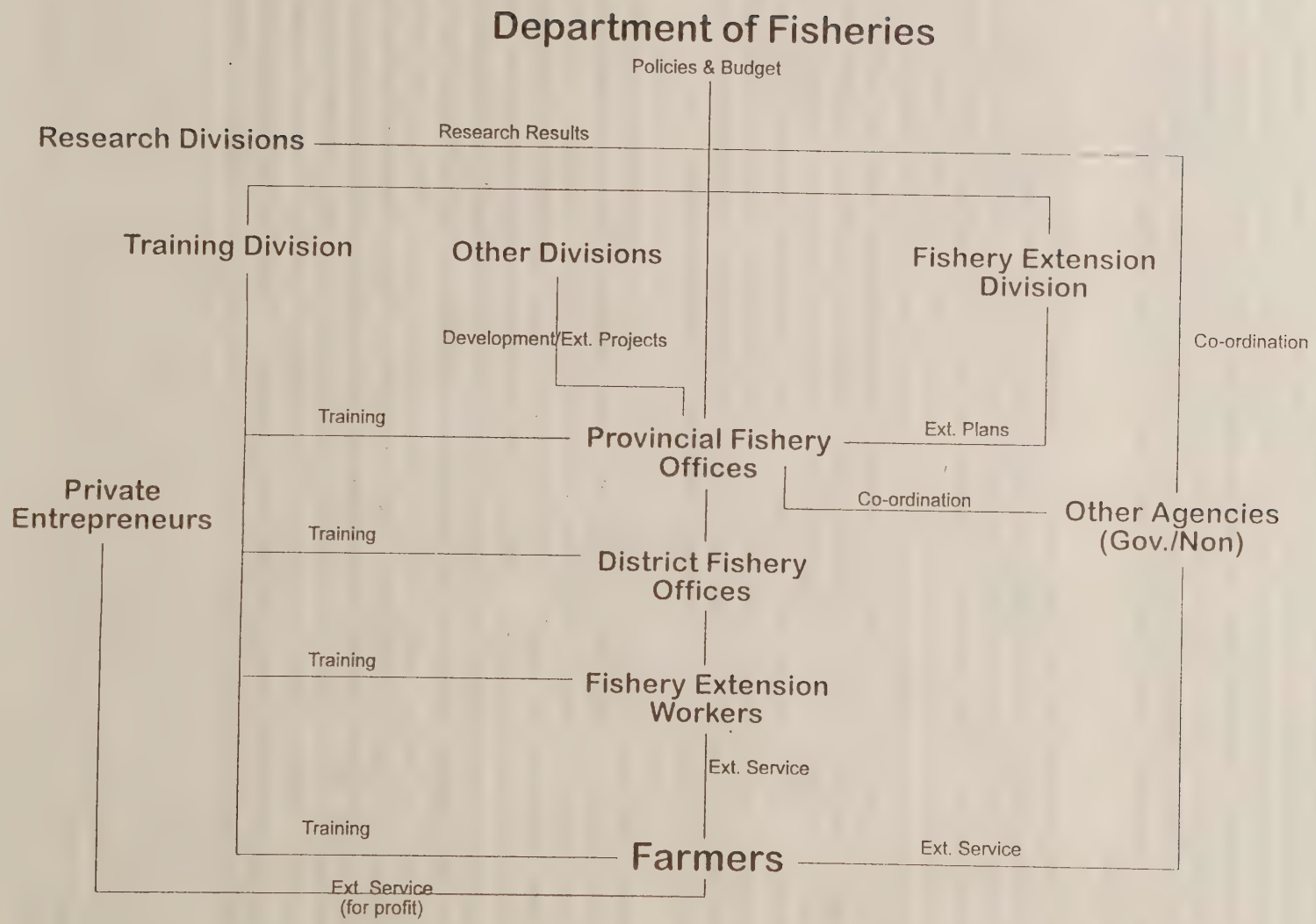

Figure 5: Aquaculture extension organization in Thailand

4.2 *Extension Policy, Planning and Programmes*

In 1985, the Royal Thai Government and the Canadian International Development Agency (CIDA) signed a Memorandum of Understanding (MOU) and approved a Plan of Operation (PO) to support the Northeast Fishery Project (NFP). The goal of the project is to improve rural nutrition and income particularly of poorer farmers, within the context of integrated rural development in the Northeast Region of Thailand.

Among numerous activities undertaken under this project, the sub-regional programme under the extension element was designed to test the concept of decentralization on a sub-regional basis and to coordinate NFP's multi-disciplinary resources in support of three DOF fish production initiatives. These include strengthening of the Village Fish Pond (VFP)/School Fish Pond Programmes (SFPP), strengthening of the Fish in the Rice Field Programme (FRFP), and strengthening of the Accelerated Aquaculture Programme (AAP).

These three major activities under the sub-regional project were found to be very successful. The VFP was successful in motivating rural farmers. The rigorous application of the process-oriented development approach led to success through the analysis of problems and identification of solutions in conjunction with village groups. The organization of strong fish pond management committees was the key to the success. Under the SFPP, the preparation of a comprehensive school fish pond curriculum and support materials in conjunction with the Primary Education Department resulted in acceptance of this curriculum which were distributed to schools in Kalasin and Nakorn Ratchasima Provinces. Discussions would be undertaken with the National Office of Primary Education to introduce the curriculum and support materials nation-wide in the future. In the FRFP, activities based on two-way communication has been very successful. There has been a 100% increase in the number of people growing fish in the rice fields since the activity began in 1987 and a 50% increase in the number of people practising pond culture in the sub-region. Communications with farmers were analyzed and services to farmers with ponds were improved. Using a multi-medium approach, with radio programming, print media, education of extension workers, village broadcasting systems and farmer conferences, aquaculture in backyard ponds has increased.

To determine the effectiveness of the programmes of the Extension Division, the organization was reviewed during the inception phase of NFP. It was concluded that the Extension Division seemed to work in isolation rather than as a service division to the fisheries station staff and researchers. One weakness was seen to be a lack of knowledge of the Extension staff in table fish production methods. Training courses for DOF staff were supported as part of the project. Freshwater fish culture curricula were prepared for DOF staff, farmers and teachers, designed to suit the needs, conditions and resources of the Northeast. To make the DOF trainers more effective, a programme was designed and implemented to improved the DOF trainers' capabilities in the area of training design and delivery. These trainers have been involved on a continued basis in the training of the staff of government and non-government organizations and rural farmers in freshwater fish culture methodologies. This training has been effective in increasing the manpower efforts targeted at fish production and in the consumption of freshwater fish to improve nutrition (The Northeast Fishery Project, 1990).

Under the Northeast Fishery Project, DOF experimented with developing new approaches to transferring information at the village and individual farmer level. Temporary Extension Workers (TEWs) were hired and trained to deliver extension services in specific districts

and villages. TEWs supported the DOF extension service by working as catalysts and facilitators at the local level. DOF staff and stations provided technical expertise and support, and extension materials. Each TEW was provided with a camera to produce media materials to improve the effectiveness of extension delivery. This programme has been evaluated and the results published. Results indicate that the approach was extremely successful in motivating people to become involved in fish production. An alternate strategy for DOF to consider for the future maintenance of a TEW-type programme include the External Extension Manpower approach. The extension activities under NFP have allowed DOF to increase its extension manpower without increasing its own human resources. The models that have been tested should be continued as a part of regular DOF programmes. The NFP also assisted the Extension Division of DOF to make existing resources more effective (the Northeast Fishery Project, 1990).

In 1992, the Fishery Extension Division started to build-up a database for aquaculture extension services on a provincial basis (Fishery Extension Division, 1992). The information collected so far indicate that there are some large potential areas for further aquaculture development.

Table 16 lists 34 aquaculture and fisheries development programmes undertaken by DOF (DOF, 1993a). Objectives of these programmes include aquaculture extension, increase of fish production in natural waters by means of stockings, fish culture in village ponds, coastal aquaculture, fish export promotion and training in aquaculture for fish farmers. Most aquaculture development programmes are operated by the Fishery Engineering Division, Provincial Fisheries Offices and Freshwater Fisheries Division. Three programmes are operated by the Coastal Aquaculture Division, and only eight programmes are operated solely by the Fishery Extension Division.

Approximately 723.6 million baht (U.S.$ 28.9 million, U.S.$ 1 = 25 baht) was allocated in 1993 budget for aquaculture extension activities. This was about 29% of the total budget of DOF in 1993 (Bureau of Budget, 1994).

4.3 Methods and Systems of Extension

Aquaculture extension is somewhat different from general agriculture extension. Still, most methods in aquaculture extension are borrowed from those of agriculture extension. Jitanand (1993) listed six important approaches in operating extension work. These include (i) to initiate extension programmes from the local level, (ii) to understand problems of fish farmers and their families, (iii) to cooperate with fish farmers in solving their problems, (iv) to assert that new technologies are really useful, appropriate and practical, (v) to serve fish farmers'needs, and (vi) to use existing resources and structure in establishing local leaders and cooperatives.

Table 16 : Aquaculture Development Programmes

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
1 Fisheries Extension	1993	Aquaculture extension	128.7	Fishers,Fish farmers	FED
2 Nation-Wide Fish Stocking	From 1977	Fish produciton,Fishery conservation	6.3	Fishers,Fish farmers	FED
3 Village Fish Pond Development in Thai-neighboring Borders	1992-1996	Fish production,Increase village income, Fishculture in schools,Fishery conservation		Fishers,Fish farmers	FEnD,PFO
3.1 Thai-Laos border			2.2		
3.2 Thai-Kampuchea border			2.8		
3.3 Thai-Myanmar border			0.8		
3.4 Thai-Malaysia border			0.7		
4 High-Land Fisheries Development	1992-1996	Fish farm promotion,Fish culture in schools, Household fish culture	0.5		FEnD,PFO FED
5 Tungkula Fishery Development	From 1983	Increase fish production,Tech nical training	2.9	Fish farmers	FED,PFO
6 Farm-Pond Agriculture Development in Huay Mong,Nong Kai	1992-1996	Fish production,Technical experiment	0.5	Fish farmers	FED
7 Fishery Development for Nation-Security in Na Hauy,Loei province	1990-1993	Increase fish production,Fish culture training for pupils,Increase fish farmers knowledge and experience in fish culture	0.4	Fish farmers,pupils	FEnD,PFO

Table 16 : Aquaculture Development Programmes (continued)

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
8 Fishery Development for Nation-Security in Phu-Kad,Phu-Miang, Phu-Soi-Dao,Pitsanulok province	1990-1993	Increase fish production,Fish culture training for pupils,Increase fish farmers knowledge and experience in fish culture	0.3	Fish farmers,young people	FEnD,PFO
9 Fishery Development for Nation-Security in Doi-Yao,Doi-Pha-Ji, Doi-Mon Chiangrai and Phayao provinces	1990-1993	Increase fish production,Fish culture training for pupils,Increase fish farmers knowledge and experience in fish culture	0.4	Fish farmers,pupils	FEnD,PFO
10 Green Northeast	1990-1996	Promote integrated Fish culture,cage culture, Fish-cum-rice culture, Increase fish Production and income	17.4	Fish farmers	FEnD,PFO
11 Fishery Development for Nation-Security in Watershed Area of Nan province	1993-1996	Increase fish production,Promote school fish culture,Government-Farmers cooperation	1.0	Fish Farmers,Pupils	FEnD,PFO
12 Fishery Development for Kirirat, Pobpra,Tak province	1993-1995	Fishery conservation,Fish production,School fish pond,Household fish pond	0.8	Fish Farmers, Pupils	FEnD,FED

Table 16 : Aquaculture Development Programmes (continued)

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
13 Fishery Development in 5 Provinces, Southern Thailand	1992-1996	Fish production,School fish pond,Training in Fish culture,Village fish culture,Increase village income	2.9	Fish Farmers, Teachers Pupils	FEnD,PFO
14 Fish Culture Demonstration in Kao-Hin-Son,Chacoengsao province	From 1988	Fish production,Village fish pond	1.3	Fish farmers	FED
15 Fish Culture Extension in Lahansai, Burirum province	From 1983	Fish stocking,Fish [illegible] Village fish culture	0.6	Fish farmers	FED
16 Fishery Study and Development in Kung Krabane Bay,Chantaburi province	From 1983	Fish stocking,Training farmers	6.3	Fish Farmers	CAD
17 Fish Culture Demonstration in the Taksin Royal Palace,Narativad province	From 1983	Fish stocking,Fish breeding	0.9	Fish Farmers	FED
18 Nam-Kek Fishery Development, Petchaboon province	From 1985	Fish culture,Fish stocking	0.9	Fish Farmers	FEnD

Table 16 : Aquaculture Development Programmes (continued)

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
19 Huay-Lan Fishery Development, San-Kam-Pang,Chingmai province	Form 1988	Fish culture,Fish stocking	0.5	Fish Farmers	FEnD
20 Mae-Ping Fishery Development, Chiangmai province	From 1987	Fish culture,Fish stocking	0.4	Fish Farmers	FEnD
21 Freshwater Fishery Resources Development	From 1990	Fish culture,Fish stocking	22.7	Fish Farmers	FED
22 Mae Aao Royal Fishery Development,Chantaburi province	From 1993	Fish culture,Fish stocking	1.2	Fish Farmers	FEnD
23 Kung Krabane Bay Fishery Development,Chantaburi province	1993	Shrimp culture extension,Study of environmental impacts	1.4	Fish Farmers	CAD
24 Phupan Royal Fishery Development, Sakon Nakorn province	From 1984	Fish culturedemonstration,Cage culture Pond culture	0.4	Rural communities	FED
25 Huay Sai Royal Fishery Development Petchaburi	From 1989	Integrated fish farming,Fish culture Extention,School fish pond	0.1	Fish farmers,Pupils	PFO

Table 16 : Aquaculture Development Programmes (continued)

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
26 Village Fish Pond Development	1982-1996	Increase fish production and income	299.5	Rural Communities	FEnD,PFO, FED
27 Small-Scale Fishery Development Phase II	1994	Increase fishermen income	116.9		FEnD,PFO, FED
28 Phi-Kun-Tong Fish Culture Narathivad province	1983	Extension and demonstration of fish culture, Cage culture,Training of fish processing	1.6	Fish farmer	
29 Doi-Tung Fish Culture,Chiangrai province	1988-1993	Fish culture extension	1.5	Fish farmer	FED
30 Pak-Panang Shrimp Culture, Nakornsrithammarat	1993	Complete operation in shrimp culture	17.3	Fish farmer	FEnD
31 Sea Farming	1993	Coastal aquaculture system development	6.3	Fish farmer	CAD,PFO
32 Fishery Development in Irrigational Area, Nothern part of Thailand	1991-1993	Increase fish production,Research and development in fish culture	Loan 1.1 RTG 0.08	Fish farmer	FEnD

Table 16 : Aquaculture Development Programmes (continued)

Programmes	Period of operation	Objective	1993 Budget (Million bath)	Target groups	Operating agencies
33 Sea Water Irrigation for Shrimp Culture	1993	System development for shrimp culture	63.3	Fish farmer	CAD
34 Commercial Fish Culture Development	1992-1994	Fish export promotion	10.7	Fish farmer	FEbD,PFO, FED

FED = Fishery Extension Division

FEnD = Fishery Engineering Division

PFO = Provincial Fisheries Office

CAD = Coastal Aquaculture Division

Aquaculture extension in Thailand is administered by DOF who also administers most of the research in aquaculture. DOF has aquaculture information needed by fish farmers. The aquaculture extension sources in Thailand is like a "delivery system". In the delivery system of extension, extension agent is the one who has access to the information needed by the farmers. Its main function is to provide information to its clients. Therefore, the main purpose of DOF's extension is basically to deliver the information to the farmers. Also, the DOF's extension system is somewhat oriented to technology transfer (DOF, 1992).

A new trend is now developing. The whole extension system is now being focused more on the farmers' needs and the information that is more appropriate to the needs and conditions of the farmers. An appropriate aquaculture technology is then developed and transferred to the farmers. The research activities in aquaculture should be directed to the needs of the farmers or to solve the problems of the farmers who are the main focus of the extension. This would lead to the establishment of a close and strong linkage between research and extension.

DOF is now implementing the Aquaculture Extension Packages for Occupational Development Project. The strategy of the project is to propose a series of ready-made extension programmes in an integrated package to farmers for their selection based on their own needs and potentials. At present, the following 19 packages are included in the project.

1) Monoculture of carp
2) Monoculture of tilapia
3) Monoculture of catfish
4) Monoculture of sea bass
5) Monoculture of grouper
6) Polyculture of carp, tilapia and catfish
7) Integrated fish culture with swine
8) Integrated fish culture with chicken
9) Integrated fish culture with horticulture and swine
10) Fish culture in rice field
11) Fish processing as smoked products
12) Fish processing as fish ham
13) Fish processing as fish ball
14) Fish processing as shredded fish
15) Shrimp culture
16) Sea bass culture in pen
17) Grouper culture in pen
18) Frog culture
19) Crocodile culture

DOF also arranges long-term loan for each programme with low interest rate and provides technical supports to farmers who enroled in such programmes. The philosophy behind these programmes is to provide opportunities to farmers to improve their aquaculture practices and related activities from subsistence level to semi-commercial level. In addition, the programmes are aimed at increasing of fish production for rural consumption as well as to enable farmers to develop their own decision making capabilities.

4.4 Extension Methods

Several methods of extension are employed in aquaculture extension in Thailand. They are both individual and group methods. Some of the extension methods used in aquaculture extension in Thailand are described below.

Personal contact (Farm visit)

This method is commonly used by the fisheries extension workers. It is the basic extension method that requires few additional resources. It is also considered as one of the most effective extension methods. The main purposes of this method are to encourage the farmers who are the target of extension to practise recommended aquaculture practices and to help them to solve their problems. DOF has set up provincial fisheries offices in almost every province and there are hundreds of district fisheries offices. Staff of these offices are the main force for extension activities. In this method, extension workers visit farmers' farms and advice them about new aquaculture techniques and/or how to solve their existing problems in aquaculture. Since the number of the extension staff of DOF is relatively small when compared to the number of farmers to be served, most extension workers tend to select wealthy farmers or village leaders as their target farmers because they are better equipped to adopt the recommended practices. At the same time, the poor farmers who should be the main target for extension are neglected.

Training

Training is the most popular extension method for transferring new technologies to farmers. Usually, training is organized by DOF to introduce existing aquaculture practices to farmers who are interested and/or to introduce new or improved aquaculture technologies to practising fish farmers. It is usually conducted for from one day to seven days. In a training session, there are various teaching techniques. Lecture is one of the techniques frequently used. Besides, there are also practical demonstration and field trips. These techniques are used in order to gain the most effective result from the training. However, it was found that only a few farmers made use of their knowledge gained from training. From the results of the evaluations of the past training courses, it can be concluded that the best training results can be achieved if the following strategies are taken into account:

1. Planning of the training must take into account the real needs of the trainees and then the trainees with the same needs are selected into the same training course.

2. Course content is well selected to be directed to the needs and potentials of the trainees.

3. The trainer should be a resourceful person in the subject matter and should also know how to transfer his/her knowledge to the trainees.

4. The most important of all, a training programme can be more effective if it is combined with other extension methods. For instance, after the end of any training, it is necessary to follow up the programme by setting up result demonstration and conducting farm visit in order to encourage the trainees to use their knowledge obtained from the training programme.

5. A training programme may be designed for local leaders who could serve as a secondary extension workers. Such a programme will be very useful in helping DOF extension workers to reducing their work load. Moreover, local leaders would have more time to contact the target group in remote areas and thus strengthen communication and extension services.

Result Demonstration

Result demonstration is also one of the most popular extension methods used in aquaculture extension in Thailand. Its main purposes are to encourage the trained farmers who adopted the recommended practices and to trigger interest among the farmers who have no experience in any kind of aquaculture practices. Demonstration plots are usually set up in farmers' ponds. The farmers who cooperate with DOF to set up the demonstration plot usually receive some of the necessary aquaculture inputs such as lime, fertilizer, fish seed, and feed. In some cases, the farmers may receive only fish feed. They have to follow the recommended guidelines strictly and the extension workers will visit and give them advice regularly. At the end, the farmers will harvest and keep all the fish. In this method, a pond owner serves as an information source of aquaculture. As the farmer has similar pond conditions as the target group, this makes the result demonstration method very persuasive. It can make the nearby farmers feel that if the demonstration pond owner can simply do it, they should be able to do it too. The drawback of this method is that if the DOF gives too much help and subsidies to the demonstration pond owners, the other farmers will feel that they would never be able to do the same because they have to use their own resources. The other practical problem is that the extension workers usually tend to select the demonstration plot from the farmer with whom they are familiar. These farmers are usually the ones who always receive help from the government or who is beter off than other farmers. In some cases, the extension workers just select the demonstration plot because they want to reward or to please someone. This can make result demonstration less effective.

Mass media

Mass media is one of the extension methods used to reach a large number of audience. It is used in the form of printed matters, video tape, television and radio broadcasting. It is usually employed by the central extension office because it is quite expensive and difficult to prepare. Some mass media used in aquaculture extension are as follows:

i. **Printed materials** are the most popular mass media in extension. They are usually in the form of booklets, fact sheets, posters, pamphlets, etc. They are prepared in the central extension office and then distributed to all the fisheries offices and stations. Then, they are given out to farmers and other interested people. The contents of the printed materials are usually about general practices of aquaculture or the information that are interesting to most farmers. The main purpose of this is to provide written information to farmers who are interested in the subject. However, the printed materials may not be highly effective to persuade farmers to change their behaviours or their attitudes. The other disadvantage is that it is expensive and difficult to prepare good printed materials. To the farmers in Thailand, comprehensive printed materials with multi-coloured pictures are found to be well received.

ii. **Television and radio broadcasting** are usually used for audio-visual transmission of new/improved technologies in aquaculture or specific aquaculture information to the general audience. Most Thai farmers have at least one television and a radio set at home. It can be noted that the television broadcasting programmes are perceived as very credible and reliable. After an aquaculture programme has been broadcast, farmers and general public usually call for more information. Some aquaculture practices (e.g. frog culture) are well adopted by the farmers mainly because they were periodically broadcast through TV and radio programmes. At present, DOF has only one or two regular fisheries programmes which are broadcast through radio. But there is no regular TV programme at the moment. The aquaculture programmes are also broadcast by other government and private agencies and by the TV stations themselves from time to time.

The main target for the extension method by TV broadcasting is usually the innovative farmers who are ready to learn new things and have enough resources for trial, whereas the radio broadcasting method is for the less innovative farmers.

4.5 Transfer of Fish Culture Technologies

Aquaculture technologies in Thailand have developed very rapidly making the country one of the leaders in aquaculture production. This achievement has been brought about by the joint efforts of the government and private sector. However, the government has played a very important role in the development. Especially in brackishwater aquaculture, Thailand is now the number one exporter of cultured marine shrimps in the world.

There are various kinds of fish and other aquatic animals which are popularly cultured in Thailand. These involved a number of technology packages. Particularly, a package of aquaculture technology of a particular fish may include breeding, nursing, feeding, disease control, farm management and so on. Usually, these technologies are transferred to the farmers as a package. The farmers are the ones who select, with assistance from the extension workers.

There are certain kinds of fish that DOF recommends to the farmers. The fish species that are recommended varies according to his/her need which is directed by the market, land location, resources availability and water supply. However, it should be noted that the marketing factor is the most important factor for DOF extension planning process. DOF usually introduces herbivorous fishes such as Nile tilapia, common carp, Thai silver barb, snake-skin gourami, Chinese carps and Indian carps to the low income farmers. These fishes are easy to be cultured and require low initial investment. The most important point is that the farmers can use residue from agricultural activities as fish feed which can lower the cost of fish culture. Fish harvested are consumed within the family and the rest are sold in the local markets within easy reach. Carnivorous fishes are more difficult to culture and the investment cost being higher are recommended for the farmers who are better off or the farmers who have enough experience in fish culture. In carnivorous fish culture feed costs are quite high. Catfish, snake-head fish, giant freshwater prawn, sand goby, sea bass, grouper, giant tiger prawn, banana prawn are among the popular carnivorous fish/shrimp in Thailand. Their culture require high cost feed which usually are marine trash fish and pelleted feed. The technologies required for the culture of these species are complicated and the operations are capital intensive.

Fish culture in the ricefields is a good example of aquaculture technology package which has been transferred to many farmers with limited resources. This kind of aquaculture technology requires low initial investment and operating cost. It is suitable for most of the rice farmers who are the majority in the rural area of Thailand. At the beginning, it requires some modification of the rice plot to make it more suitable for fish culture. This modification can be done manually by family labour or by machine. It requires some investment for stocking fish in the rice field. Fish feed is not necessary for this kind of aquaculture technology since fish stocking density in the field is relatively low. Fish can feed on natural food contained within the rice field. However, fertilizer and supplemental feed from agricultural byproducts can be used to achieve higher fish production.

The DOF has been researching for new species/varieties to introduce for culture. One of the most successful research was a new hybrid of walking catfish. It is the result of cross breeding between *Clarias gariepinus* and *Clarias macrocephalus*. The most popular walking catfishes cultured in Thailand were *C. batrachus* and *C. macrocephalus* but the farmers who culture them faced the problems of repeated disease outbreaks. Income form farming of these catfishes were low. Introduction of the new hybrid which is disease resistant has been very successful.

4.6 Input Supplies and Subsidies

In order to accelerate the rate of adoption of recommended aquaculture practices among farmers, it is necessary to provide not only information through extension services but other essential inputs as well. In aquaculture extension services provided by DOF, the following incentives are offered to the farmers.

Credit

Investment cost is one of the most important factors that affect farmers' decision to adopt aquaculture practices recommended by the extension workers. Providing easy access to fund sources is a big help to farmers. DOF has set up a fund of about 16 million bahts with low interest rate for the fishermen and fishfarmers. The interest rate per annum for the credit is 9% which is much lower than the credit from private sources and a little bit lower than that from other government sources. There are some conditions applied to the farmers who want to avail of this credit facility. For instance, they have to be a practising aquaculturist; they have to use that money only for aquaculture purposes; and they must have assets to guarantee the loan. For aquaculture purposes, farmers can borrow upto 100,000 bahts from the fund which has its payback period of three years. This fund is not sufficient to meet the demand for credit. Most farmers therefore have to search for other sources of credit. In some cases, extension projects may also provide credit to its clients.

Fish seed and other farm supplies

Fish seed and other necessary farm supplies are also essential inputs that help adoption of recommended aquaculture practices. Especially, supplying fish seed free of cost is one of the best incentives. At present, DOF administers 55 freshwater fisheries stations and 22 coastal aquaculture stations in Thailand. These stations take responsibility for producing fish seed for stocking natural waters and for supplying free of cost to fish farmers. They also produce fish seed for selling to farmers at a reasonable price. The price of fish seed may be set by the DOF to control the price of fish seed sold by the private fish farms.

In addition to fish seed, DOF also provides other necessary farm inputs such as lime, fertilizer, feed, etc. These inputs may be given to farmers free or at a reduced price. Moreover, incentives through aquaculture extension may be provided in the form of free/reduced cost of services of farm machineries to construct fish ponds for fish farmers.

The main purpose of subsidies is to help decrease costs of investment in order to accelerate adoption process by fish farmers. The amount of incentives or subsidies giving out to each farmer depend mainly on his/her economic status. Farmers with sufficient resources do not need to wait for subsidies from the government. Most subsidies in aquaculture extension is provided only at the beginning of the first year in order to build up self-reliancy among the farmers who receive extension services.

4.7 Control Mechanisms

Rungrawd (1994) listed some major problems affecting the agricultural extension system. These include inability of government officials, farmers, and village organizations to draw up a rural development plan to solve problems; inability of the people's organizations to manage extension programmes at the village level; lack of support from the government in terms of supplying accurate and fast information that facilitate planning at the community level; centralization of financial management in government's project; and weak participation of the private sector in drawing up the provincial and the district development plans to integrate central policies into local needs. The aquaculture extension systems also suffer from similar problems. Extension control mechanisms can be summarized as follows:

i) Progress report

Progress report is a routine work for extension workers who are responsible for operating a project. The progress report usually include detailed information on progress, obstacles and financial status of the on-going project. The progress report for each project is usually submitted on a monthly or bi-monthly basis. Most extension projects are normally operated by local extension workers in the field. These extension workers are staff of the district fishery offices. In every month or every two months, a progress report for each project is submitted to the provincial fisheries office. The provincial fisheries office then compiles and submits it to the Fishery Planning and Policy Division of the DOF. These progress reports are then used for project monitoring and management.

ii) Monitoring

Each project of the DOF is monitored regularly by different levels of management. A project may be monitored by the field extension workers of a provincial fisheries office, by the Project Division or by an Inspector-General of DOF. The project monitoring is aimed at facilitating project advancement according to project plan by identifying operational problems/bottlenecks and recommending corrective measures.

iii) Evaluation

Evaluation is usually done at the end of the project or at the end of the fiscal year. Most project evaluations are mainly initiated and executed by the Project Division. The main objectives for most evaluations are to review effectiveness of the project in serving its initial objectives and to assess the project benefits and drawbacks which may occur. In an

evaluation, it usually employs fishery staff from the central office and does not use local staff mainly to avoid bias and to increase its creditability. In some cases, local provincial fishery offices may initiate their own evaluation processes in an informal fashion. Sometimes, an extension project may hire external experts to conduct its evaluation process to ensure its own creditability. These external experts are usually from universities.

4.8 Extension and Research Linkage

It is realized that the results of research may not be adopted by food producers simply because researchers have published their results in reputable academic journals. The rate of adoption by fishfarmers is directly dependent on the effectiveness of extension workers and the services provided by them in the field (Juntarashote and Daosukho, 1986).

In the past, most research and extension activities in aquaculture were executed by the fisheries stations located in the provinces. Most knowledge in aquaculture were generated within the station or from the other stations before the station staff would disseminate those knowledge to the farmers.

Now, the DOF, as the main institute for aquaculture research and extension, has a clear separation between research and extension work. Most research activities are carried out by fisheries stations and some of DOF's divisions, whereas all the extension works are carried out by the provincial fisheries offices located in the provinces of Thailand. Still, the mechanism to link between research and extension in aquaculture has not yet been established in a formal fashion. In practice, some linkage between research and extension is made possible through the personal contacts between the provincial fisheries staff and the researchers in the Research Division/Institutes. This depends very much on the relationship between those two parties/persons. Thus, the linkage between them may be impaired if the personal relationship between the extension staff and the research staff are negative. Training courses for extension workers, where the researchers are used as trainer/instructors, also provide some scope for linkage between research and extension. Due to DOF's administrative system, the linkage can be made only through the top-down administration approach. Formally, research information from the researchers can only go to their immediate supervisor in the headquarters, and from there to the immediate supervisor of the extension workers. This approach tend to be a time consuming method and the information get distorted by the time it reaches the extension workers.

However, almost all fisheries stations still serve as an extension post. One of the functions of fisheries stations is to produce fish seeds, some of which are distributed to fish farmers as an incentive. Through this channel, it provides a chance for researchers at the fisheries station to meet fish farmers. If farmers has a technical problem in aquaculture practices, they are likely to receive advice from fisheries biologists at fisheries stations.

In the long-run, it is essential that formal linkages between research and extension are established. This linkages must allow information to flow consistently and reliably back and forth from research units to extension units and to the farmers and vice versa. In the near future, the provincial fisheries offices in every province will have a separate extension section to control and regulate extension activities. This unit, along with some communication channels to be set up, would certainly help to establish and strengthen the linkage between research and extension.

4.9 NGOs in Extension

Jantarashote (1994) stated that private sectors in Thailand play important role in the development of capture fisheries (boat and fishing gear construction, technology transfer, and joint venture fishing), aquaculture (private fish farm), fish processing (cold storage, fish processing technologies) and marketing (local and foreign markets). He also pointed out that the private sector should take a leadership role in the development of Thai fisheries, whereas DOF should cooperate and support them under fishing regulations to equally allocate to people the benefits derived from fisheries resources.

Aquaculture technologies have been seen as an alternative means for rural development. Besides the government organizations, there are many non-government organizations who also use aquaculture extension as one of their strategies to bring in development among people in the rural area. These are both foreign and domestic organizations. Mostly, these organizations use aquaculture as a part of their extension services. There are very few organizations that have full time aquaculture extension workers.

5. CONCLUSION

Aquaculture extension services in Thailand have achieved a great deal of success during the last decade. Aquaculture production has increased by 4.5 times, from 82,700 tons in 1982 to 371,000 tons in 1992. The number of fish farmers has increased from 74,971 in 1988 to 103,790 in 1992. The number of aquaculture cooperatives has increased from only 1 in 1981 to 12 in 1992. However, lack of credit facilities, infrastructure and technical information for rural farmers have hindered further development of aquaculture.

The Department of Fisheries established the Fisheries Extension Division in 1987 to plan and administer extension activities. The Provincial Fisheries Offices within each province are regional offices that play important roles in providing extension services to fish farmers. Aquaculture extension services in Thailand have been designed and operated like a delivery system (delivering the technologies and information to the farmers). However, there is a new trend in which aquaculture extension services would be more directed to meet the needs and to solve the problems of the farmers rather than just to obtain technological information and to extend such information to the farmers. However, the extension and research linkage will have to be formally established and strengthen. Training of aquaculture extension workers and fish farmers should be expanded to develop the human resources that would be required for sustained development of aquaculture.

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